5-A-36

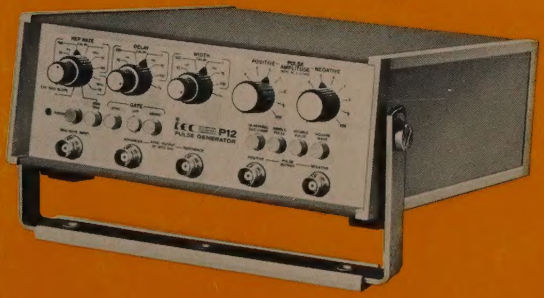
INSTRUCTION MANUAL

VIKING LABORATORIES INC.

INTERSTATE P12

PULSE GENERATOR

MP MASTER
MA28301



INTERSTATE ELECTRONICS CORPORATION
Subsidiary of A-T-O Inc.

A free instruction manual is provided with each instrument

Serial number .....

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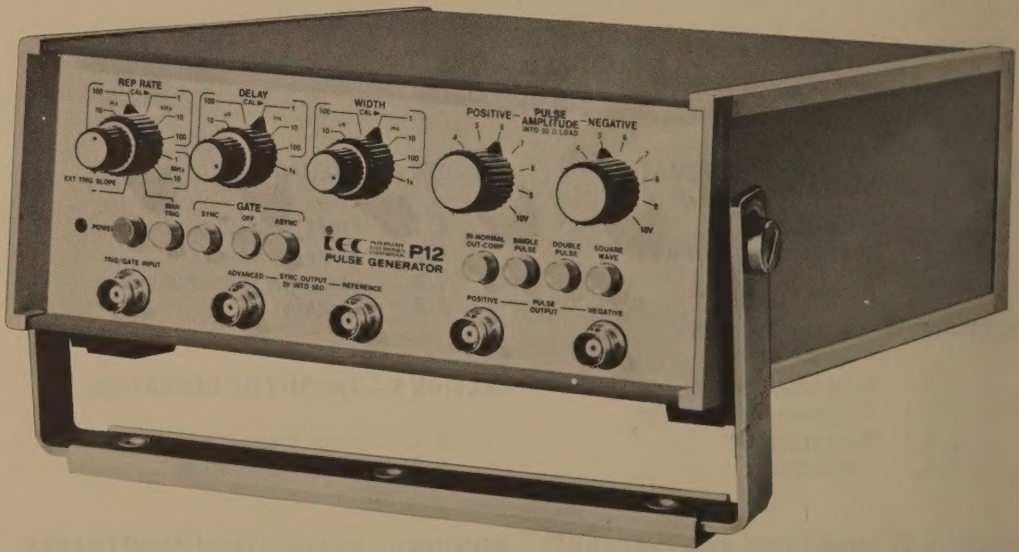


FRONTISPIECE

SECTION 1 — GENERAL INFORMATION

1-1 Introduction

The Interstate P12 Pulse Generator is an advanced, very versatile and low-cost instrument designed for general purpose applications.

The instrument is characterized by:

- 0.01-Hz minimum repetition frequency
- 1-sec maximum pulse delay
- 1-sec maximum pulse width
- a duty cycle normal, complemented, or fixed at 50 percent.

Accessories:

The instrument is supplied with an A-C cord.

Optional accessory: rack mounting kit.

1 - 2 Physical characteristics:

Dimensions (see figure 1):

- Wide: . . . . . 8-3/4" (222 mm)
- Deep: . . . . . 10-5/8" (270 mm)
- High: . . . . . 3-3/8" (85 mm)
- Weight: . . . . . 7.7 lb (3.5 kg)

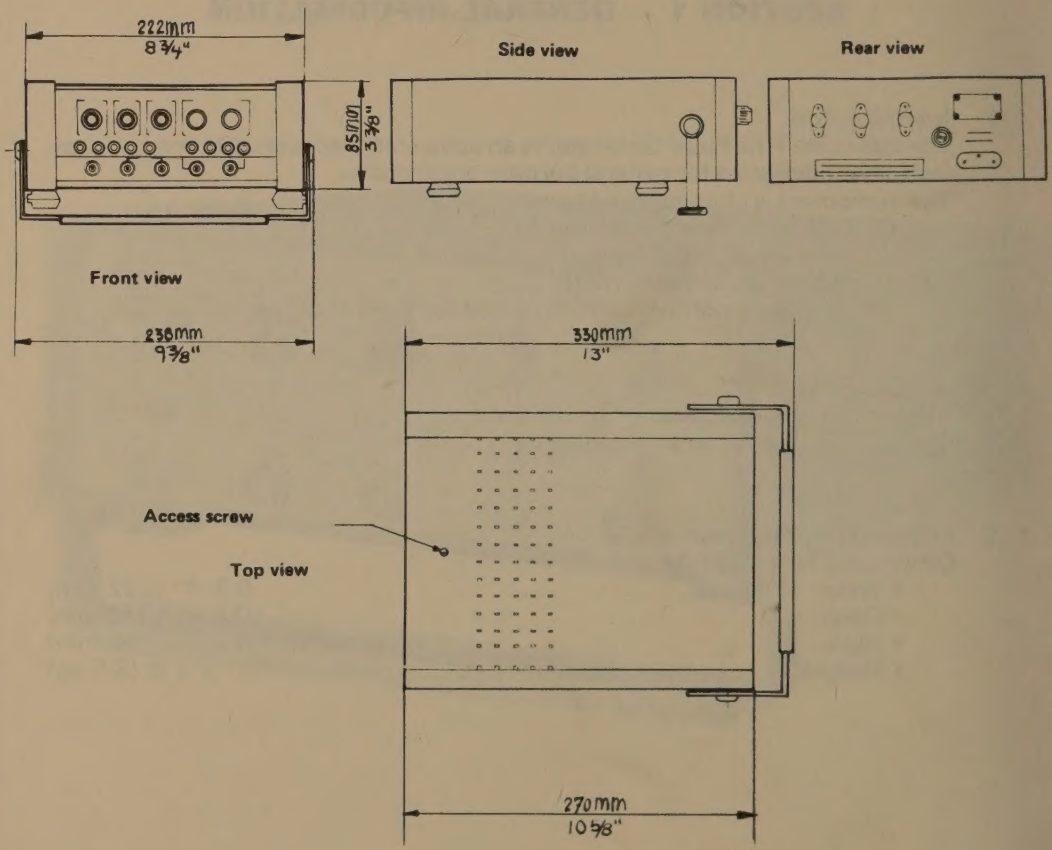


Figure 1 — Mechanical Outline

SECTION 2 — SPECIFICATIONS

2-1 Pulse characteristics:
These characteristics are specified with the outputs loaded by 50Ω.

2-1.1 Internal repetition rate:
Adjustable from 0.01 to 10 MHz

- by 9 step selector: 0.01 Hz - 0.1 Hz; 0.1 Hz - 1 Hz; 1 Hz - 10 Hz; 10 Hz - 100 Hz; 100 Hz - 1 kHz; 1 kHz - 10 kHz; 10 kHz - 100 kHz; 100 kHz - 1000 kHz; 1 MHz - 10 MHz.
- by vernier between ranges.
- Frequency jitter: 10^{-3} +0.5 ns.
- Double pulse mode: up to 10 MHz (5-MHz clock repetition rate).
- Square wave mode: up to 5 MHz (10-MHz clock repetition rate).

2-1.2 Pulse delay (see figure 2):
Adjustable from 50 ns to 1 s (the leading edge of the pulse output is delayed from the advanced sync output by Θ +110 ns ±20 ns, Θ being the pulse delay):

- by 8-step selector: 50 ns - 100 ns; 100 ns - 1 μs; 1 μs - 10 μs; 10 μs - 100 μs; 100 μs - 1 ms; 1 ms - 10 ms; 10 ms - 100 ms; 100 ms - 1 s.
- by vernier between ranges.
- Pulse delay jitter: 10^{-3} +0.2 ns.

2-1.3 Pulse width:
Adjustable from 50 ns to 1 s:

- by 8-step selector: 50 ns - 100 ns; 100 ns - 1 μs; 1 μs - 10 μs; 10 μs - 100 μs; 100 μs - 1 ms; 1 ms - 10 ms; 10 ms - 100 ms; 100 ms - 1 s.
- by vernier between ranges.
- Pulse width jitter: 10^{-3} +0.2 ns.

2-1.4 Duty cycle:
Normal and complement. Maximum pulse width duty cycle is near 100 percent. In normal mode, maximum duty cycle is $>$50 percent.

2-1.5 Transition time:
Rise and fall time $<$5 ns (10 percent to 90 percent of pulse amplitude).

2-1.6 Amplitude:
Simultaneous positive and negative outputs. Adjustable from 1 V to 10 V.

2-1.7 Waveform aberrations:
Overshoot, undershoot, ringing, etc., are $<\pm$5 percent full amplitude.

2-1.8 Output protection:
Sync and pulse outputs are protected against accidental output shorts and overloads. It is recommended that PULSE AMPLITUDE settings be reduced below 10 volts when outputs are unloaded.

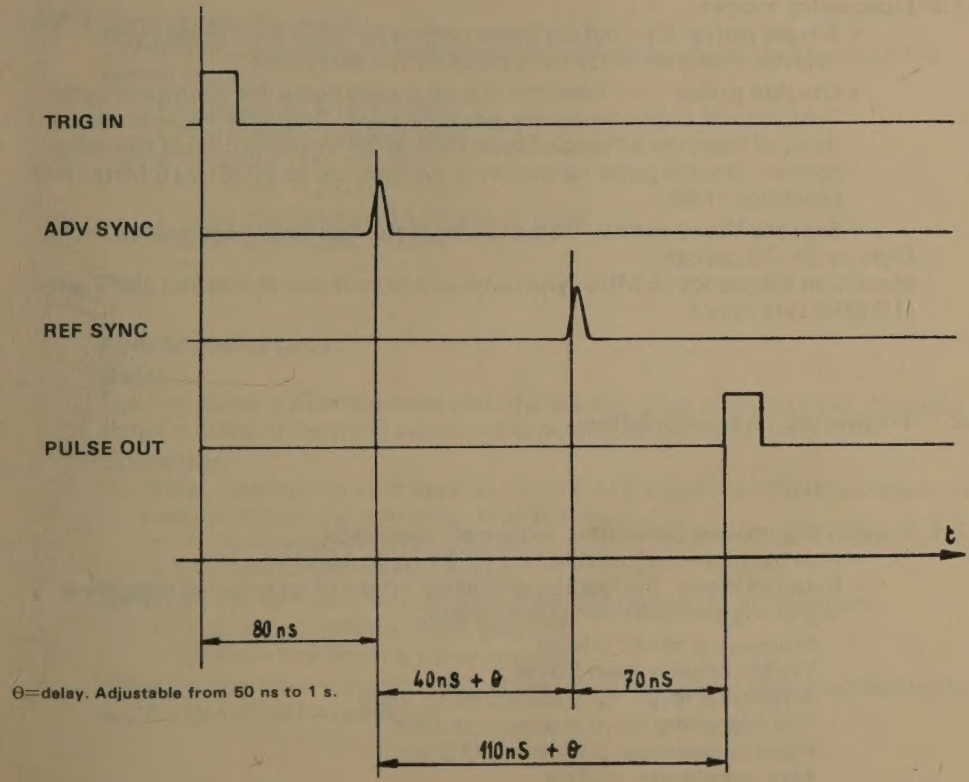


Figure 2 — Timing cycle

2-1.9 Operating modes:

- **Single pulse**: One output pulse occurs for each sync pulse cycle, delayed from reference sync pulse by the delay time.
- **Double pulse**: Two identical output pulses occur for each sync cycle. One pulse at approximatively advanced sync time and the second one delayed from the advanced sync time pulse by the setting at the delay control. Double pulse operation is available up to 10 MHz (5-MHz clock repetition rate).
- **Square Wave mode**: Output pulse state changes at each clock cycle.

Duty cycle: 50 percent.
Maximum frequency: 5 MHz sync outputs are available at internal clock rate (10-MHz rate max.)

2-2 Triggering characteristics:

2-2.1 Triggering modes (internal - external - manual):

- Internal mode: adjustable from 0.01 Hz to 10 MHz.
- External mode: the leading or trailing edges of an external triggering signal triggers the main pulse output:

  Frequency: 0 to 10 MHz
  Width: greater than 50 ns
  Amplitude level: +2 V minimum to +5 V
  The triggering input is direct-coupled
  Input impedance: 3 kilohms//15 pF
  Max. amplitude: ±20 V

- Manual mode: Operation of a front panel pushbutton provides one cycle of single or double pulse output. In square wave mode the output pulse state changes.

2-2.2 Gating (see figure 2):

Synchronous or asynchronous pulse trains can be generated through the gating input:

- Frequency: 0 to 10 MHz
- Pulse width: greater than 50 ns
- "0" level: 0 to + 0.4 V
- "1" level: + 2 V to + 5 V
- Input impedance: 3 kilohms // 15 pF
- Max. amplitude: ±20 V

Synchronous gate:

Delay:

The first pulse is synchronized with the leading edge of gate signal. The gate signal is delayed from the advanced sync output by 80 ns ± 15 ns.

Operation:

(1) When a gating signal is applied to the GATE input (the SYNC pushbutton being pushed), the operation is as follows:
- "1" state enables pulse outputs
- "0" state inhibits pulse outputs

(2) When the OFF pushbutton is pushed, the operation is as follows:
- "1" state inhibits the pulse outputs
- "0" state enables the pulse outputs

When an operation without GATE is required, the gating signal applied to the GATE input must be removed.

Asynchronous gate:

The cycle begins with the first internal clock pulse occuring after the leading edge of the gate signal.

2-2.3 Synchronization outputs:

- Amplitude: greater than + 2 V into 50-ohm load.
- Width: 16 ns ± 5 ns (at 50 percent of signal amplitude).
- Leading edge transition time: 6 ns ± 2 ns.
- Advanced sync output

Occurs coincident with each clock signal, advanced 110 ns ±20 ns +Θ(Θ being the delay time) from the main output pulse, in single pulse mode (see figure 2).

- Reference sync output.

Occurs advanced 70 ns from the leading edge of the main output pulse, in single pulse mode (see figure 2).

2-3 Power required:

- 100 V ± 10 percent - 115 V ± 10 percent
- 200 V ± 10 percent - 230 V ± 10 percent
- 50 Hz to 400 Hz - 30 VA

(Note: To change power supply voltage refer to paragraph 4.2).

2-4 Environment:

- Operating temperature: 0°C to +50°C.
- Storage temperature: —20°C to + 70°C.
- Humidity: 80 percent RH at 20°C, linearly decreasing from 80 percent to 0 percent, from + 20°C to + 50°C.

SECTION 3 — INSPECTION AND CHECKOUT

3-1 Unpacking and inspection:
Before accepting the instrument from the carrier, inspect the shipping container for external damage. Any sign of external damage must be noted by customer and called to the attention of the carrier.

As soon as the equipment is unpacked, inspect the instrument for damage in shipment. Check for scratches or dents and damaged switches or connectors. If damage is noted, do not use the instrument unless instructed by the Interstate Electronics representative.

3-2 Reshipment:
When a damaged instrument is to be returned to the factory for repair or service, contact your nearest Interstate Electronics representative for written permission to ship, for shipping instructions, and for a shipping form. Such action will ensure expedient repair and return of the instrument.

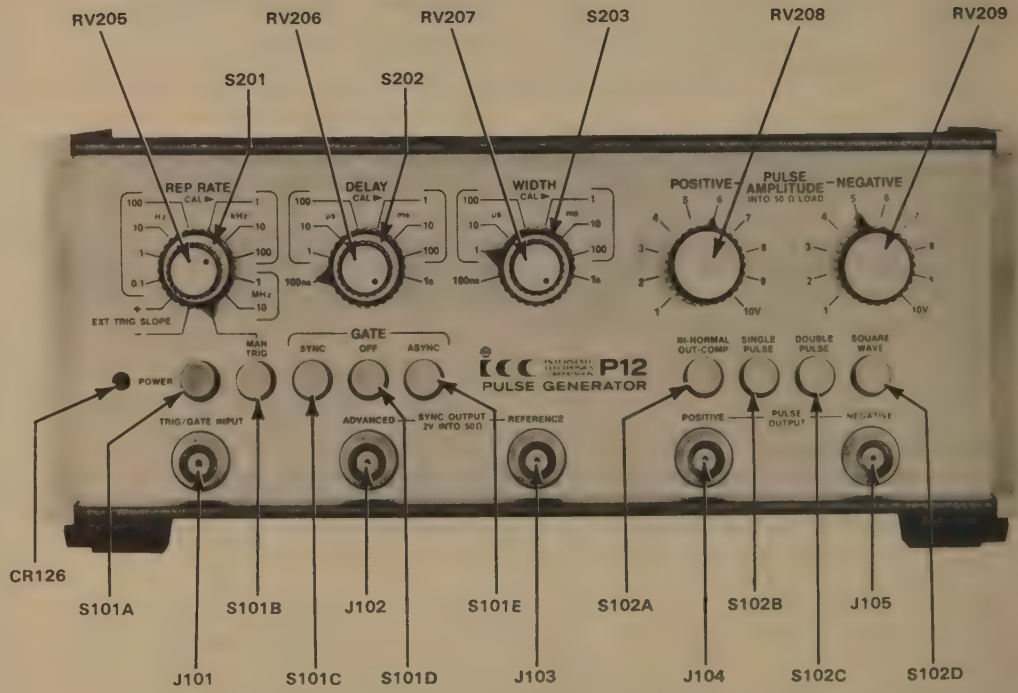


Figure 3 — Front panel description

SECTION 4 — OPERATION

4-1 Front-panel description (see figure 3):

Ref. No.	Description
S101A	Power switch
S101B	Manual triggering pushbutton
S101C	Synchronous gate pushbutton
S101D	Operation without gating
S101E	Asynchronous gate pushbutton
S102A	Normal/Complement duty cycle pushbutton
S102B	Single pulse mode pushbutton
S102C	Double pulse mode pushbutton
S102D	Squarewave mode pushbutton
J101	External triggering or gate input
J102	Advanced sync output

Ref. No.	Description
J103	Reference sync output
J104	Positive pulse output
J105	Negative pulse output
CR126	Pilot lamp
S201	Repetition rate rotary switch
RV205	Repetition rate vernier
S202	Pulse delay rotary switch
RV206	Pulse delay vernier
S203	Pulse width rotary switch
RV207	Pulse width vernier
RV208	Positive output amplitude control
RV209	Negative output amplitude control

4-2 Placing in operation

The instrument leaves the factory set to operate from 104 V to 126 V a-c power supplies. When operating from other voltages, remove the top cover by rotating the screw at the rear a quarter turn, lift the cover, and slide forward. Set the switches located on the printed circuit board in the correct position corresponding to the required a-c line voltage (see figure 4).

Change the fuse corresponding to the selected voltage:

Fuse 100 - 127 V: .5 A slow-blow
Fuse 200 - 252 V: .25 A slow-blow

Spare fuses are stored inside the instrument. Replace with Bussman, type GMA, Littlefuse type 213, or equivalent.

4-3 Operating considerations

The output pulses are generated by current sources, which must be loaded by 50 ohms. Set the front-panel controls as follows:

- REP RATE rotary switch to 10 kHz (vernier set at CAL).
- Pulse DELAY rotary switch to 0.1 μs (vernier set at CAL).
- Pulse WIDTH rotary switch to 100 ns (vernier set at CAL).
- Push the OFF gate pushbutton.
- Push the NORM-COMP pushbutton.
- Push SINGLE PULSE.
- Set AMPLITUDE controls to 10 V.
- Synchronize the scope with ADVANCED sync.
- Examine the waveform of POSITIVE PULSE OUTPUT (figure 5).
- Examine the waveform of NEGATIVE PULSE OUTPUT (figure 5).

Caution: If the AMPLITUDE controls are set to 10 V, do not maintain the instrument powered when the main pulse outputs are not connected to 50-ohm load. When one output only is used, set the vernier of the other output back to minimum.

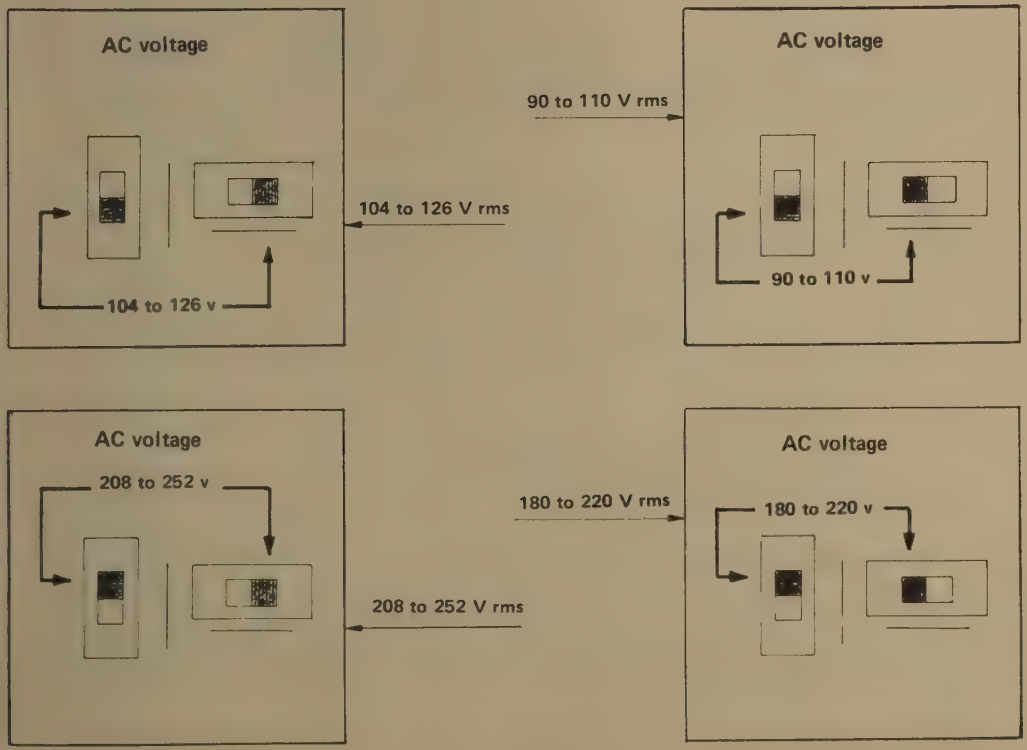
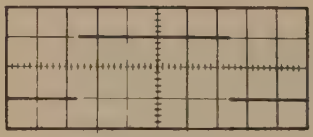
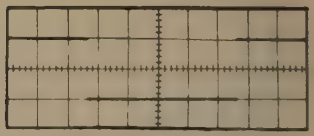


Figure 4 – AC line voltage adjustment



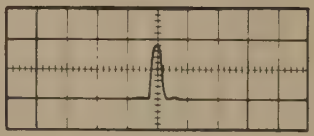
POSITIVE OUTPUT

Horiz. : 2 µs/Cm
Vert. : 5 v/Cm



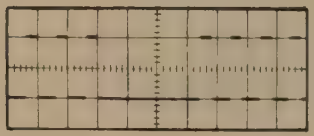
NEGATIVE OUTPUT

Horiz. : 2 µs/Cm
Vert. : 5 v/Cm

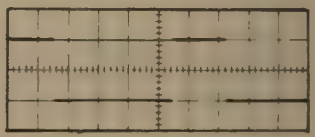


SYNC. OUTPUT

Horiz. : 50 ns/Cm
Vert. : 2 v/Cm



SYNCHRONOUS GATE OPERATION



DOUBLE PULSE OPERATION

Figure 5 — Waveforms of output pulses

SECTION 5 — THEORY OF OPERATION

5-1 Block diagram description (see figure 6).

The A201 internal oscillator can be triggered in the four following modes:

- Continuous operation (input/output feedback through a time constant)
- External triggering
- Manual triggering
- Synchronous gate

The clock frequency is divided by A202, A203, and A204 decade circuits to provide the ranges: 10 Hz, 1 Hz and 0.1 Hz. The clock output signal (TP A) is applied to A205 delay one-shot and is amplified by Q102 to become the ADVANCED SYNC output.

Output from the A205 delay one-shot is applied to:

- A206 width one-shot (TP E)
- A207 double pulse circuit (TP B)
- A101 JK-flip-flop
- Q103 amplifier to become the reference sync output

Signal applied to duty cycle reversing (COMP) stage comes either from width one-shot in the single or double pulse mode (TP C), or from JK-flip-flop in squarewave mode.

A102 and A103 circuits invert the signal to provide the complement function. Their output is fed to the output amplifiers (TP F and TP G).

The output amplifiers are complementary. The level of those amplifiers is a function of the setting of built-in current sources.

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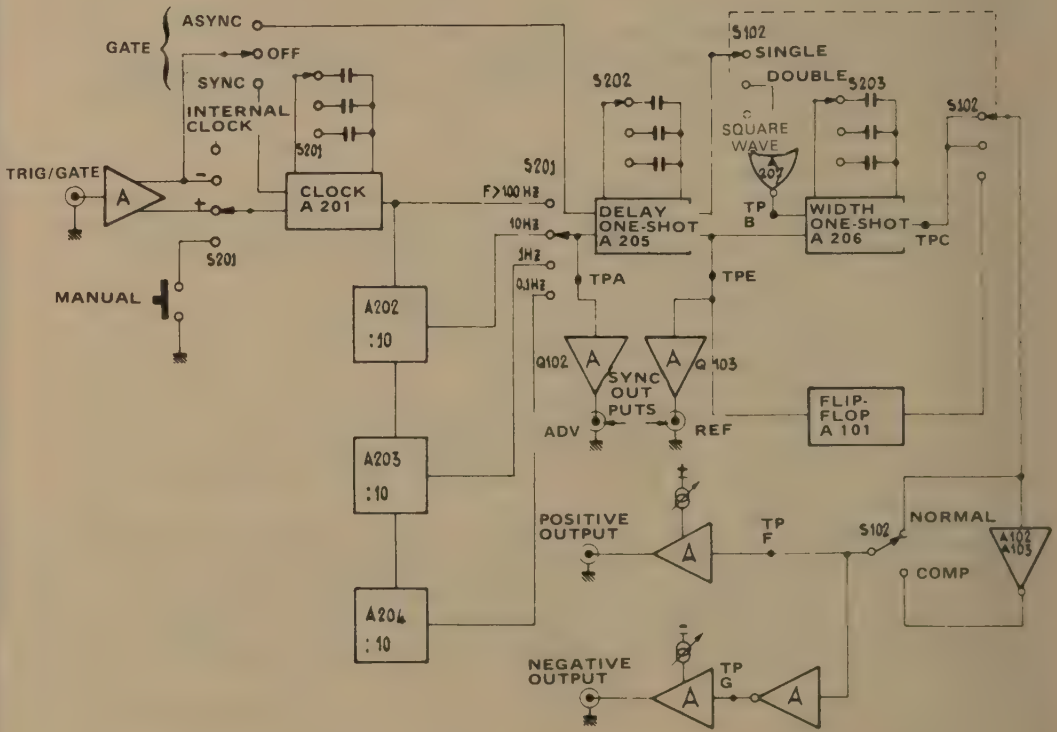


Figure 6 – Block diagram

5 - 2 Circuit description (see figure 7 and schematic foldout)

5-2.1 Internal oscillator:

The internal oscillator consists of an emitter-coupled integrated circuit, A201, and R-C networks which determine repetition rate. At rest, the gate input, pin 12, is biased into the active region by a +3.75 V (at 25°C) reference voltage. The reference voltage is compensated to track the gate threshold shift in order to stabilize oscillator frequency versus temperature. Feedback capacitors connect the noninverting output, pin 15, back to the input.

When a positive variation occurs on A201 output, this variation is coupled through capacitors C202 to C207 to the input and maintains the "1" state. The capacitor discharges to +3.75 V through resistor RV205 until the circuit switches to the "0" state. This in turn is coupled through the capacitor to the input to maintain the "0" state until the capacitor charges to +3.75 V through RV205 and circuit again switches to the "1" state.

In the external trigger mode, the oscillator feedback loop is disabled by grounding pin 12 of A201 through R220. The trigger signal applied to a second input (pin 13) of A201 after being suitably sharpened and level shifted by Q101, A104, and A201.

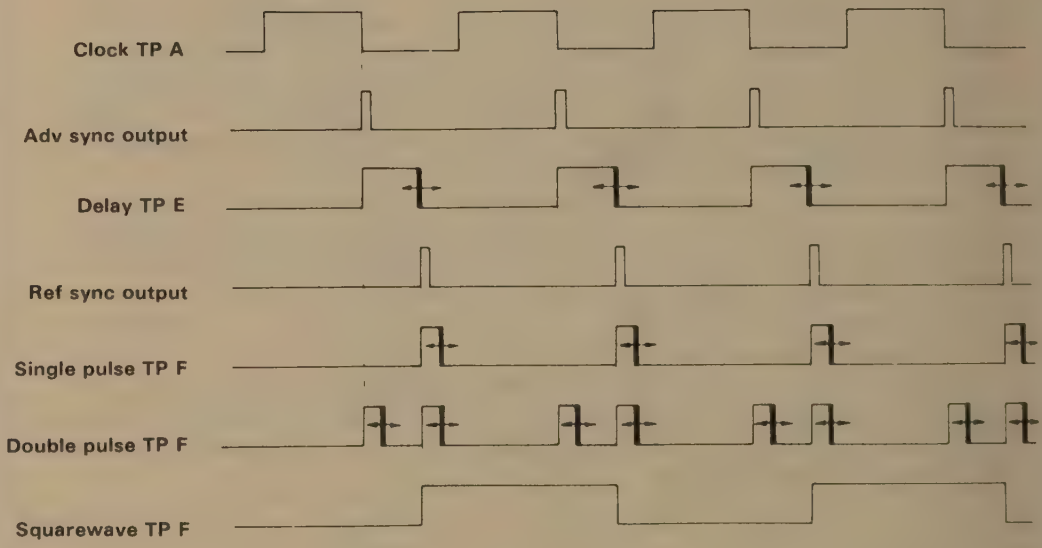


Figure 7 – Internal oscillator waveforms

In the manual trigger mode, the oscillator input is again grounded. When the MAN TRIG pushbutton is pushed, a charged capacitor C125 is discharged across R219 to trigger A201.

In the synchronous gate mode, the clock is driven through Q101, A104, and A201. The "NOR" output (pin 16) is applied through buffer Q203 to decade counters A202, A203, A204, and to the input of the trigger-forming one-shot A207. One output of A207 triggers the delay one-shot A205; the other output of A207 drives Q102 to form the advanced sync output.

In the asynchronous gate mode, the clock operates normally to provide continuous trigger pulses to the delay one-shot A205 and to the advanced sync output. The gating signal is applied to an enabling-gate input of A205.

The trailing edge of the delay one-shot output (pin 6) triggers the width one-shot A206 and a pulse-forming one-shot A102, which in turn drives Q103 to provide the reference sync output.

The leading edge of delay one-shot output (pin 1) feeds pulse-forming one-shot A207. In the double pulse mode, this signal triggers the width one-shot at the beginning of the delay period on pin 4.

The trailing edge of the delay one-shot also triggers J-K flip-flop A101. In the squarewave mode, the width one-shot is disabled and the A101 output is used to drive the output circuitry.

Logic gates A102 and A103 provide inversion for the normal/complement function for either the width one-shot or the flip-flop output.

5-2.2 Output amplifiers:

The output of gates A102 and A103 is fed to the output amplifiers. Each output stage consists of an adjustable d-c source connected to the output terminal via a diode. A transistor switch shunts this current to ground between pulses. To produce a pulse, the switch is opened and the current is diverted to the output load. Because the circuits are complementary, only the positive amplifier will be described.

Q204, Q108, and Q109 constitute the d-c source. RV208 is the front-panel control that adjusts the magnitude of the current. In the absence of a pulse, test point F is held near ground, causing Q104 to conduct heavily. The conduction of Q104 provides sufficient base current through R121 and CR110 to saturate Q106 and Q107. When saturated, Q106 and Q107 shunt the current from Q108 and Q109 to ground and no current flows to the load.

A positive signal at test point F will turn off Q104. Q106 and Q107, deprived of base current, become nonconducting and the current from Q108 and Q109 is shunted to the output load via CR114. Prior to the pulse, C113 is charged to approximately 9 volts. This charge is used to turn on Q105 during the leading edge of the pulse. The momentary conduction of Q105 aids in the rapid turn-off of Q106 and Q107. The nonlinear conduction characteristic of CR114 prevents the saturation voltage of Q106 and Q107 from appearing at the output terminal. CR113 and CR112 provide a protective shunt path for current in absence of a load.

SECTION 6 — CALIBRATION / MAINTENANCE

6-1 Equipment required:

- Oscilloscope, 100 MHz bandwidth, e.g.: Tektronix 454.
- Resistive loads, 50 ohms, 2 W.
- Digital voltmeter.

6-2 Calibration procedure (main output pulses loaded into 50 ohms):

See PC board layout diagram.

Connect a d-c voltmeter between straps and ground and check the supply voltages in the following order:

Voltages	Min.	Max.
+ 5 V	+ 4.8 V	+ 5.2 V
+11 V	+10.15 V	+12.06 V
+15 V	+14.25 V	+15.75 V
—11 V	—10.15 V	—12.06 V
—15 V	—14.25 V	—15.75 V

6-2.2 Internal oscillator calibration:

Set DELAY and WIDTH controls to 0.1 μs range. Verniers at minimum.
Adjust RV201 to obtain −1.25 V on Q201 emitter (TP D) with respect to +5 V supply.
Set REP RATE control to 1-MHz range with vernier at max.
Adjust RV201 to obtain the max frequency on the main pulse outputs.
Set REP RATE control to 10-MHz range with vernier at max.
Adjust RV202 to obtain an output pulse frequency between 10 MHz and 10.5 MHz.
Check that overrange between all ranges is greater than 2 percent.

6-2.3 Pulse delay calibration:

No adjustments
Check that overrange between all pulse delay ranges is greater than 2 percent.

6-2.4 Pulse width calibration:

No adjustments
Check that overrange between all pulse width ranges is greater than 2 percent.

6-2.5 Output amplitude calibration:

- Set REP RATE control to 0.1 MHz with vernier at max.
- Push the SQUAREWAVE mode pushbutton.
- Set AMPLITUDE controls at 10 V.

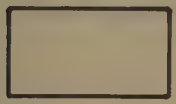
RV203 and RV204 are located on the upper PC board. C110 and C117 are located on the lower PC board.

- Adjust RV203 to obtain a +10 V pulse on the positive output.
- Adjust C110 to obtain minimum overshoots and transition times $<$5 ns.
- Adjust RV204 to obtain a −10 V pulse on the negative output.
- Adjust C117 to obtain minimum overshoots and transition times $<$5 ns.

6-3 Servicing (see figure 8):

Failures may be localized by following the procedure outlined in figure 8. Starting with the power supplies, proceed to test points in sequence.

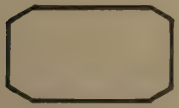
6-3.1 Symbol significance



This symbol shows the function to be tested.

This symbol shows the test point and is used as a branch point.

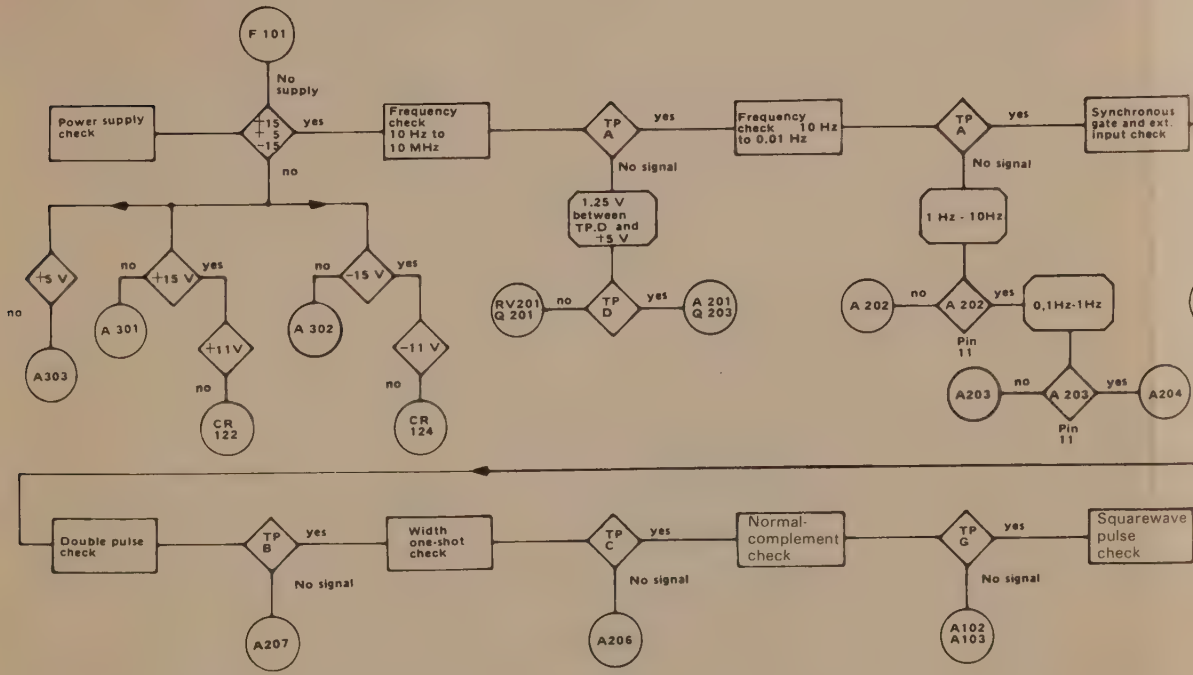
Represents the defective component or the group of components in which one element is defective.



Represents a subfunction to be tested.

6-3.2 Example:
Consider an instrument having no output signal.

Function or subfunction to be tested	Test point	Answer	Defective elements
Power supply checks	+15 V + 5 V −15 V	yes yes yes	
Rep rate checks from 10 Hz to 10 MHz	TP A	no	
1.25 V between TP D and +5 V	TP D	yes	A201-Q203


F 101
No supply
Power supply check
+15 +5 -15
yes
no
Frequency check 10 Hz to 10 MHz
TP A
yes
No signal
Frequency check 10 Hz to 0.01 Hz
TP A
yes
No signal
Synchronous gate and ext. input check
1,25 V between TP.D and +5 V
1 Hz - 10Hz
+5 V
no
A303
+15 V
no
yes
A 301
+11V
no
CR 122
-15 V
no
yes
A 302
-11 V
no
CR 124
RV201 Q 201
no
TP D
yes
A 201 Q 203
A 202
no
A 202
yes
Pin 11
0,1Hz-1Hz
A203
no
A 203
yes
A204
Pin 11
Double pulse check
TP B
yes
No signal
A207
Width one-shot check
TP C
yes
No signal
A206
Normal-complement check
TP G
yes
No signal
A102 A103
Squarewave pulse check

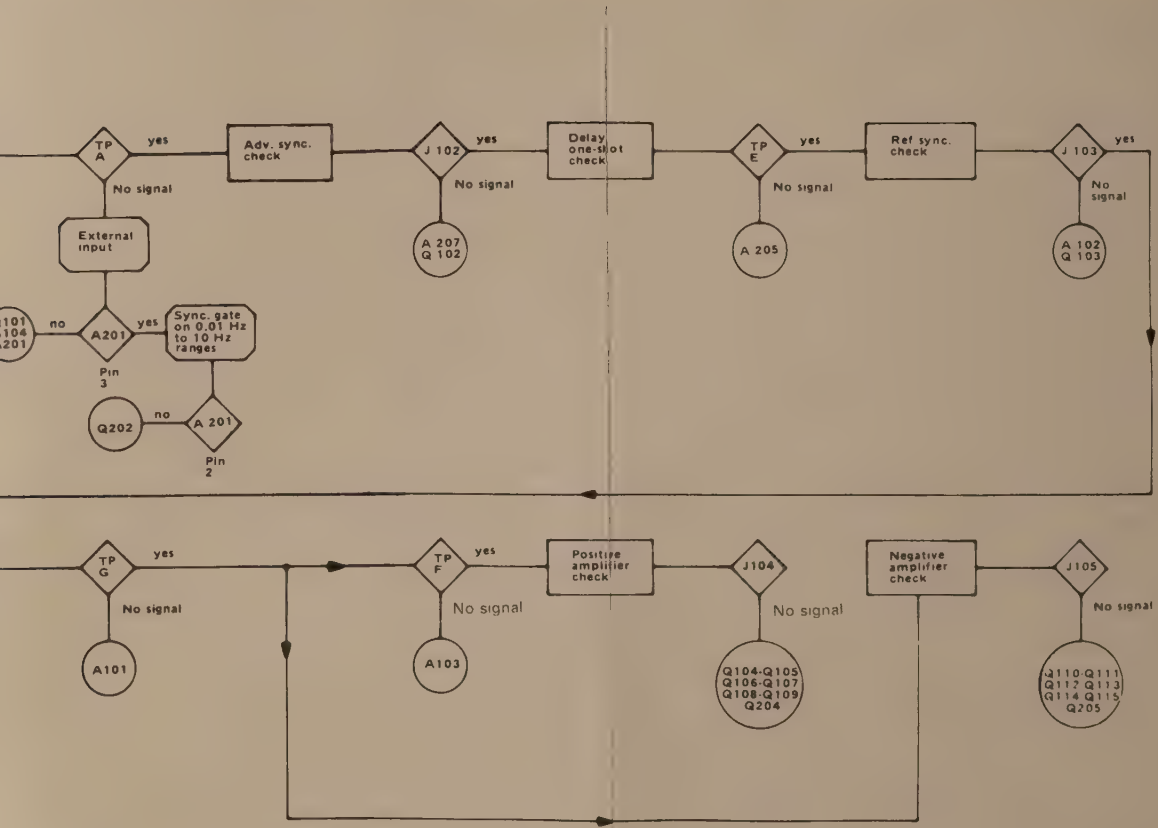


Figure 8 — Servicing Diagram

– F O L L O W I N G –

- Parts list
- Disassembly
- K 1414 PC board
- K 1416 PC board
- Power supply schematic
- Clock schematic
- Output amplifier schematic

Parts List

Ref Desig	Value	Description	Mfg Code	Part No.
A101	-	IC: 74H72 14-Pin DIP	01295	SN74H72N
A102	-	IC: 74H00 14-Pin DIP	01295	SN74H00N
A103	-	IC: 74H00 14-Pin DIP	01295	SN74H00N
A104	-	IC: 74H00 14-Pin DIP	01295	SN74H00N
A201	-	IC: 10105 14-Pin DIP	04713	MC10105L
A202	-	IC: 7490 14-Pin DIP	01295	SN7490N
A203	-	IC: 7490 14-Pin DIP	01295	SN7490N
A204	-	IC: 7490 14-Pin DIP	01295	SN7490N
A205	-	IC: 74121 14-Pin DIP	01295	SN74121N
A206	-	IC: 74121 14-Pin DIP	01295	SN74121N
A207	-	IC: 74H00 14-Pin DIP	01295	SN74H00N
A301	-	IC: 15V Regulator	0000A	L037T1
A302	-	IC: 15V Regulator	0000A	L037T1
A303	-	IC: 309K 5V Regulator	27014	LM309K
C101	1000pF	C: Mica 100V ±5%	84171	DM15-102J
C102	0.047μF	C: Ceramic 25V -20 +80%	56289	HY535
C103	0.047μF	C: Ceramic 25V -20 +80%	56289	HY535
C104	100pF	C: Mica 500V ±5%	84171	DM15-101J
C105	0.047μF	C: Ceramic 25V -20 +80%	56289	HY535
C106	1000pF	C: Mica 100 ±5%	84171	DM15-102J
C107	0.047μF	C: Ceramic 25V -20 +80%	56289	HY535
C108	0.047μF	C: Ceramic 25V -20 +80%	56289	HY535
C109	82pF	C: Mica 500V ±5%	84171	DM15-820J

Ref Desig	Value	Description	Mfg Code	Part No.
C110	7-35pF	C: Variable 160V	07421	11993C
C111	10μF	C: Electrolytic 50V ±20%	90201	MTV10CB50
C112	0.047μF	C: Ceramic 25V -20 +80%	56289	HY535
C113	47pF	C: Mica 500V ±5%	84171	DM15-470J
C114	0.047μF	C: Ceramic 25V -20 +80%	56289	HY535
C115	0.047μF	C: Ceramic 25V -20 +80%	56289	HY535
C116	82pF	C: Mica 500V ±5%	84171	DM15-820J
C117	7-35pF	C: Variable 160V	07421	11993C
C118	10μF	C: Electrolytic 50V -10 +100%	90201	MTV10CB50
C119	0.047μF	C: Ceramic 25V -20 +80%	56289	HY535
C120	47pF	C: Mica 500V ±5%	84171	DM15-470J
C121	0.047μF	C: Ceramic 25V -20 +80%	56289	HY535
C122	0.047μF	C: Ceramic 25V -20 +80%	56289	HY535
C123	1000pF	C: Mica 100V ±5%	84171	DM15-102J
C124	470μF	C: Electrolytic 40V	07421	12240W
C125	100μF	C: Electrolytic 25V -10 +100%	90201	MTV100DB25
C126	100μF	C: Electrolytic 25V -10 +100%	90201	MTV100DB25
C127	470μF	C: Electrolytic 40V	07421	12240W
C128	100μF	C: Electrolytic 25V -10 +100%	90201	MTV100DB25
C129	100μF	C: Electrolytic 25V -10 +100%	90201	MTV100DB25
C130	1000μF	C: Electrolytic 16V	07421	12235R
C131	100μF	C: Electrolytic 25V -10 +100%	90201	MTV100DB25
C132	0.047μF	C: Ceramic 25V -20 +80%	56289	HY535

Ref Desig	Value	Description	Mfg Code	Part No.
C133	12pF	C: Mica 500V ±5%	84171	DM15-120J
C134	100μF	C: Electrolytic 25V -10 +100%	90201	MTV100DB25
C201	0.047μF	C: Ceramic 25V -20 +80%	56289	HY535
C202	33μF	C: Electrolytic 15V ±5%	56289	150D336X5010B
C203	3.3μF	C: Electrolytic 20V ±5%	56289	150D335X5015A
C204	0.33μF	C: Electrolytic 35V ±5%	56289	150D334X5035A
C205	0.033μF	C: Film 100V ±2%	84411	608-33321W
C206	3300pF	C: Film 100V ±2%	84411	663UW33221W
C207	300pF	C: Mica 500V ±2%	84171	DM15-301G
C208	0.047μF	C: Ceramic 25V -20 +80%	56289	HY535
C209	0.047μF	C: Ceramic 25V -20 +80%	56289	HY535
C210	0.047μF	C: Ceramic 25V -20 +80%	56289	HY535
C211	100μF	C: Electrolytic 25V -10 +100%	90201	MTV100DB25
C212	22pF	C: Mica 500V ±1/2pF	84171	DM15-220G
C213	470pF	C: Mica 500V ±1%	84171	DM15-471F
C214	4700pF	C: Film 100V ±2%	84411	663UW47221W
C215	0.047μF	C: Film 100V ±2%	84411	663UW47321W
C216	0.47μF	C: Electrolytic 35V ±5%	56289	150D474X5035A
C217	4.7μF	C: Electrolytic 10V ±5%	56289	150D475X5010A
C218	12pF	C: Mica 500V ±5%	84171	DM15-120J
C219	0.047μF	C: Ceramic 25V -20 +80%	56289	HY535
C220	220pF	C: Mica 500V ±5%	84171	DM15-221J
C221	100pF	C: Mica 500V ±5%	84171	DM15-101J

Ref Desig	Value	Description	Mfg Code	Part No.
C222	22pF	C: Mica 500V ±5%	84171	DM15-220J
C223	470pF	C: Mica 500V ±1%	84171	DM15-471F
C224	4700pF	C: Film 100V ±2%	84411	663UW47221W
C225	0.047μF	C: Film 100V ±2%	84411	663UW47321W
C226	0.47μF	C: Electrolytic 35V ±5%	56289	150D474X5035A
C227	4.7μF	C: Electrolytic 10V ±5%	56289	150D475X5010A
C228	47μF	C: Electrolytic 20V ±5%	56289	150D476X5020C
C229	12pF	C: Mica 500V ±5%	84171	DM15-120J
C230	0.047μF	C: Ceramic 25V -20 +80%	56289	HY535
C231	100μF	C: Electrolytic 25V -10 +100%	90201	MTV100DB25
C232	0.047μF	C: Ceramic 25V -20 +80%	56289	HY535
C233	100μF	C: Electrolytic 25V -10 +100%	90201	MTV100DB25
C234	0.047μF	C: Ceramic 25V -20 +80%	56289	HY535
C235	0.047μF	C: Ceramic 25V -20 +80%	56289	HY535
C236	0.047μF	C: Ceramic 25V -20 +80%	56289	HY535
C237	100μF	C: Electrolytic 25V -10 +100%	90201	MTV100DB25
C238	47μF	C: Electrolytic 20V ±5%	56289	150D476X5020C
C239	0.047μF	C: Ceramic 25V -20 +80%	56289	HY535
C240	0.047μF	C: Ceramic 25V -20 +80%	56289	HY535
C301	0.047μF	C: Ceramic 25V -20 +80%	56289	HY535
CR101	-	Diode: Silicon	01295	1N3604
CR102	-	Diode: Silicon	01295	1N3604
CR103	-	Diode: Silicon	01295	1N3604

Ref Desig	Value	Description	Mfg Code	Part No.
CR104	-	Diode: Silicon	01295	1N3604
CR105	-	Diode: Silicon	01295	1N3604
CR106	-	Diode: Silicon	01295	1N3604
CR107	-	Diode: Germanium	03877	1N995
CR108	-	Diode: Germanium	03877	1N995
CR109	-	Diode: Zener 6.8V	04713	1N5235A
CR110	-	Diode: Silicon	01295	1N3604
CR111	-	Diode: Zener 6.2V	04713	1N5234A
CR112	-	Diode: Zener 13V	04713	1N3023
CR113	-	Diode: Silicon	01295	1N3604
CR114	-	Diode: Silicon	07263	1N3600
CR115	-	Diode: Zener 10V	04713	1N5240A
CR116	-	Diode: Silicon	01295	1N3604
CR117	-	Diode: Zener 6.2V	04713	1N5234A
CR118	-	Diode: Zener 13V	04713	1N3023
CR119	-	Diode: Silicon	01295	1N3604
CR120	-	Diode: Silicon	07263	1N3600
CR121	-	Diode Bridge: Silicon	83003	W111
CR122	-	Diode: Zener 3.9V	04713	1N3823
CR123	-	Diode Bridge: Silicon	83003	W111
CR124	-	Diode: Zener 3.9V	04713	1N3823
CR125	-	Diode Bridge: Silicon	83003	W111
CR126	-	Diode: GaAsP	50347	CSL3

Ref Desig	Value	Description	Mfg Code	Part No.
CR201	-	Diode: Silicon	01295	1N3604
CR202	-	Diode: Silicon	01295	1N3604
CR203	-	Diode: Germanium	03877	1N995
CR204	-	Diode: Germanium	03877	1N995
CR205	-	Diode: Germanium	03877	1N995
CR206	-	Diode: Germanium	03877	1N995
FE122	-	Bead: Ferrite	02114	K5001003B
FE124	-	Bead: Ferrite	02114	K5001003B
FE201	-	Bead: Ferrite	02114	K5001003B
FE202	-	Bead: Ferrite	02114	K5001003B
L101	150μH	Choke: RF (1.5Ωdc)	07421	13300Y
L102	150μH	Choke: RF (1.5Ωdc)	07421	13300Y
Q101	-	Transistor: Silicon NPN	01295	2N2369A
Q102	-	Transistor: Silicon PNP	01295	2N2894
Q103	-	Transistor: Silicon PNP	01295	2N2894
Q104	-	Transistor: Silicon PNP	01295	2N2894
Q105	-	Transistor: Silicon PNP	01295	2N2894
Q106	-	Transistor: Silicon NPN	01295	2N3013
Q107	-	Transistor: Silicon NPN	01295	2N3013
Q108	-	Transistor: Silicon PNP	01295	2N2905
Q109	-	Transistor: Silicon PNP	01295	2N2905
Q110	-	Transistor: Silicon NPN	01295	2N2369A
Q111	-	Transistor: Silicon NPN	02195	2N2369A

Ref Desig	Value	Description	Mfg Code	Part No.
Q112	-	Transistor: Silicon PNP	01295	2N2894
Q113	-	Transistor: Silicon PNP	01295	2N2894
Q114	-	Transistor: Silicon NPN	01295	2N2219
Q115	-	Transistor: Silicon NPN	01295	2N2219
Q201	-	Transistor: Silicon PNP	01295	2N2894
Q202	-	Transistor: Silicon PNP	01295	2N2894
Q203	-	Transistor: Silicon PNP	01295	2N2894
Q204	-	Transistor: Silicon NPN	01295	2N2369A
Q205	-	Transistor: Silicon PNP	01295	2N2894
R101	3K	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-302J
R102	11K	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-113J
R103	10M	R: Carbon 1/4 watt ±5%	01121	RC07GF106J
R104	100	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-101J
R105	33	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-330J
R106	100	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-101J
R107	1K	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-102J
R108	330	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-331J
R109	100	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-101J
R110	1K	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-102J
R111	100	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-101J
R112	33	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-330J
R113	6.2K	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-622J
R114	200	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-201J

Ref Desig	Value	Description	Mfg Code	Part No.
R116	6.2K	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-622J
R117	6.2K	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-622J
R118	330	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-331J
R119	1.5K	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-152J
R120	220	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-221J
R121	1K	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-102J
R122	33	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-330J
R123	33	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-330J
R124	330	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-331J
R125	20	R: Metal Glaze 1/2 watt ±5%	75042	RG1/2-200J
R126	20	R: Metal Glaze 1/2 watt ±5%	75042	RG1/2-200J
R127	1.5K	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-152J
R128	1K	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-102J
R129	390	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-391J
R130	1K	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-102J
R131	220	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-221J
R132	1K	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-102J
R133	33	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-330J
R134	33	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-330J
R135	330	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-331J
R136	20	R: Metal Glaze 1/2 watt ±5%	75042	RG1/2-200J
R137	20	R: Metal Glaze 1/2 watt ±5%	75042	RG1/2-200J

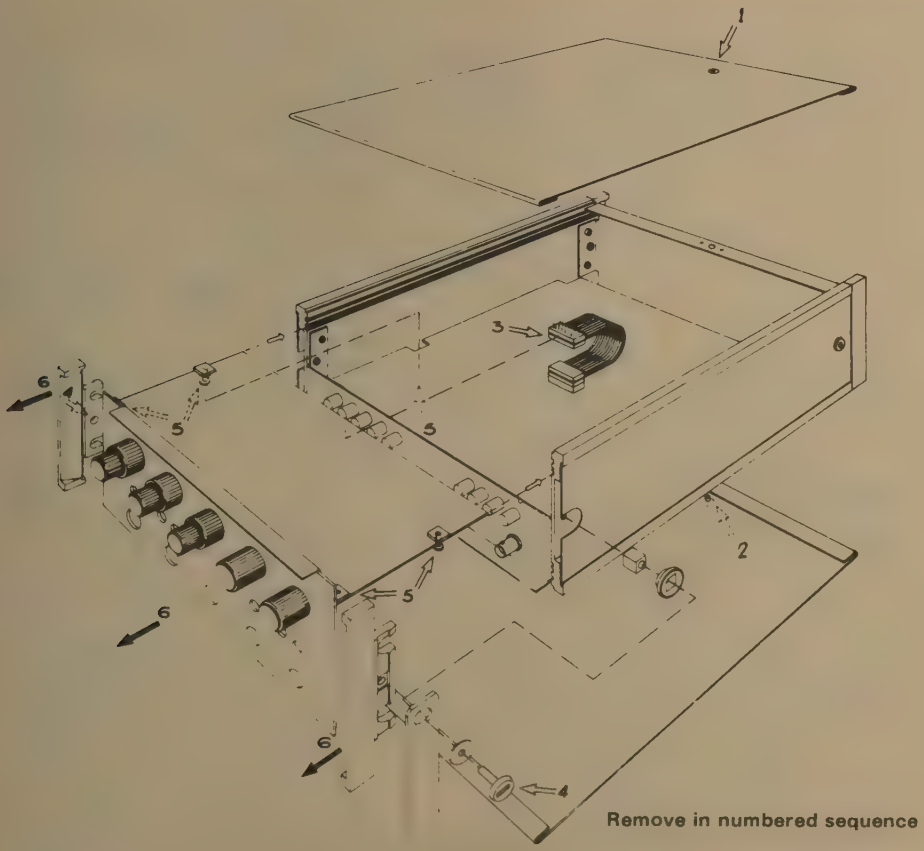
Ref Desig	Value	Description	Mfg Code	Part No.
R138	1.5K	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-152J
R139	1K	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-102J
R140	240	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-241J
R141	360	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-361J
RV201	470	R: Variable ±20%	07421	13162Y
RV202	100	R: Variable ±20%	07421	13157T
RV203	220	R: Variable ±20%	07421	13160W
RV204	220	R: Variable ±20%	07421	13160W
RV205	2.5K	R: Variable Inv Log Taper ±20%	07421	17631F
RV206	100K	R: Variable Norm Log Taper ±20%	07421	17653E
RV207	100K	R: Variable Norm Log Taper ±20%	07421	17653E
RV208	10K	R: Variable Linear ±20%	07421	17633H
RV209	10K	R: Variable Linear ±20%	07421	17633H
R210	470	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-471J
R211	2.2K	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-222J
R212	100	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-101J
R213	3K	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-302J
R214	20K	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-203J
R215	510	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-511J
R216	20K	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-203J
R217	510	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-511J
R218	510	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-511J
R219	1K	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-102J

Ref Desig	Value	Description	Mfg Code	Part No.
R220	100	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-101J
R221	510	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-511J
R222	510	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-511J
R223	82	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-820J
R224	82	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-820J
R225	2.2K	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-222J
R226	7.5K	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-752J
R227	56K	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-563J
R228	6.2K	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-622J
R229	150	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-151J
R230	330	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-331J
R231	6.2K	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-622J
R232	6.2K	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-622J
R233	7.5K	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-752J
R234	56K	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-563J
R235	2.2K	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-222J
R236	510	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-511J
R237	82	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-820J
R238	1.2K	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-122J
R239	300	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-301J
R240	1.5K	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-152J
R241	82	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-820J
R242	1.2K	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-122J

Ref Desig	Value	Description	Mfg Code	Part No.
R243	300	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-301J
R244	1.5K	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-152J
R245	6.2K	R: Metal Glaze 1/4 watt ±5%	75042	RG1/4-622J
S101	-	Switch: Pushbutton	07421	17663R
S102	-	Switch: Pushbutton	07421	17664S
S103	-	Switch: Slide	07421	17660M
S104	-	Switch: Slide	07421	17660M
S201	-	Switch: Rep Rate	07421	18442M
S202	-	Switch: Delay/Width	07421	18443N
S203	-	Switch: Delay/Width	07421	18443N
T101	-	Transformer: Power	07421	18455B
J101	-	Connector: BNC Receptacle	91836	UG1094B/U
J102	-	Connector: BNC Receptacle	91836	UG1094B/U
J103	-	Connector: BNC Receptacle	91836	UG1094B/U
J104	-	Connector: BNC Receptacle	91836	UG1094B/U
J105	-	Connector: BNC Receptacle	91836	UG1094B/U
J106	-	Socket: 16 Pin DIL IC	01295	016ST7520
J201	-	Socket: 16 Pin DIL IC	01295	016ST7520
J301	-	Connector: AC 3G	82389	AC3
F101	0.5A	Fuse, Slow-Blow, for 115V	75915	213.500
		(Alternate Supplier)	71400	GMA 0.5A
F101	0.25A	Fuse, Slow-Blow, for 230V	75915	213.250
		(Alternate Supplier)	71400	GMA 0.25A
XF101	-	Fuseholder	07421	17661N
P101	-	Cable, 16 Pin DIL Jumper, 2½"L	07421	P00339020
-	-	Line Cord, AC	70903	17258

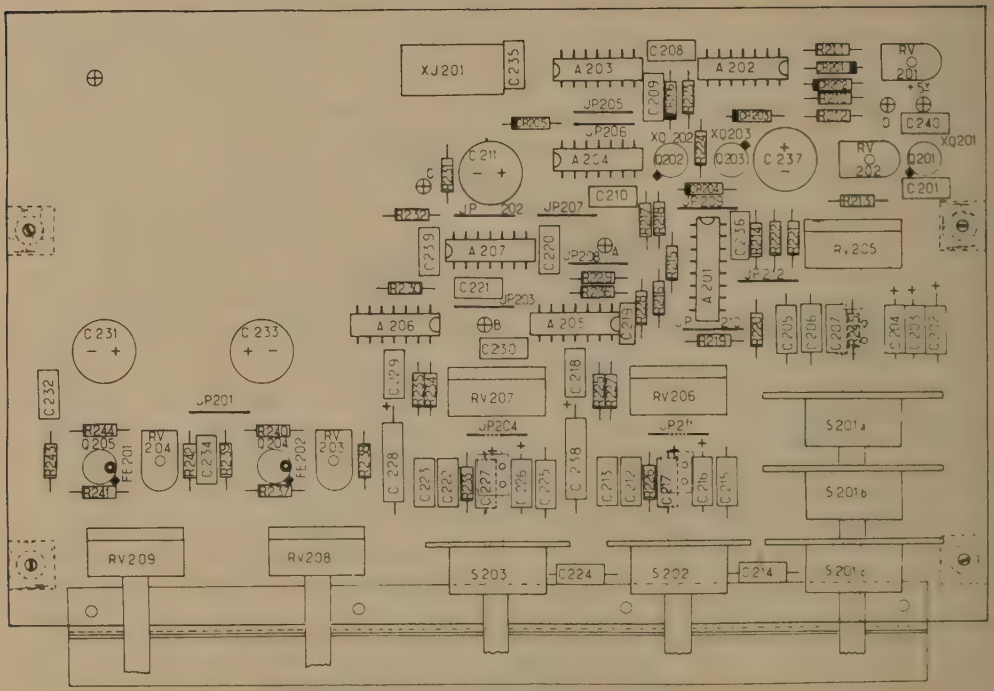
List of Manufacturers

Code Ident	Manufacturer
01112	Allen-Bradley, Milwaukee, Wisconsin
01295	Texas Instruments Inc., Semiconductor Components Division, Dallas, Texas
02114	Ferroxcube Corp. of America, Saugerties, New York
03877	Transitron Electronic Corporation, Wakefield, Massachusetts
04713	Motorola Semiconductor Products Inc., Phoenix, Arizona
07263	Fairchild Camera and Instrument Corp., Mountain View, California
07421	Interstate Electronics Corporation, Anaheim, California
27014	National Semiconductor Corp., Santa Clara, California
50347	Opcoa Inc., Edison, New Jersey
56289	Sprague Electric Co., North Adams, Massachusetts
70903	Belden Corporation, Chicago, Illinois
71400	Bussman Mfg. Div., McGraw Edison Co., St. Louis, Missouri
75042	IEC Inc., Philadelphia, Pennsylvania
75915	Littlefuse Inc., Des Plaines, Illinois
83003	Varo Semiconductor Inc., Garland, Texas
84171	Arco Electronics Inc., Great Neck, New York
84411	TRW Capacitor Division, Ogallala, Nebraska
90201	Mallory Capacitor Co., Indianapolis, Indiana
91836	Kings Electronic Co., Inc., Tuckahoe, New York
0000A	SGS-ATES Semiconductor Corp., Newtonville, Massachusetts

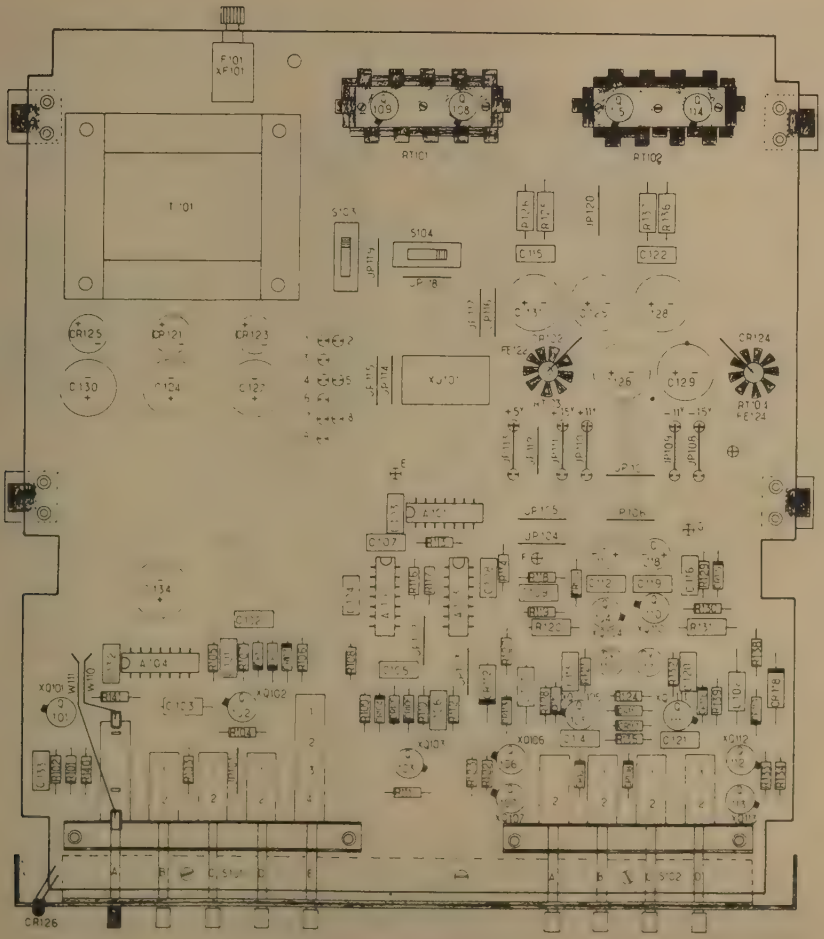


Remove in numbered sequence

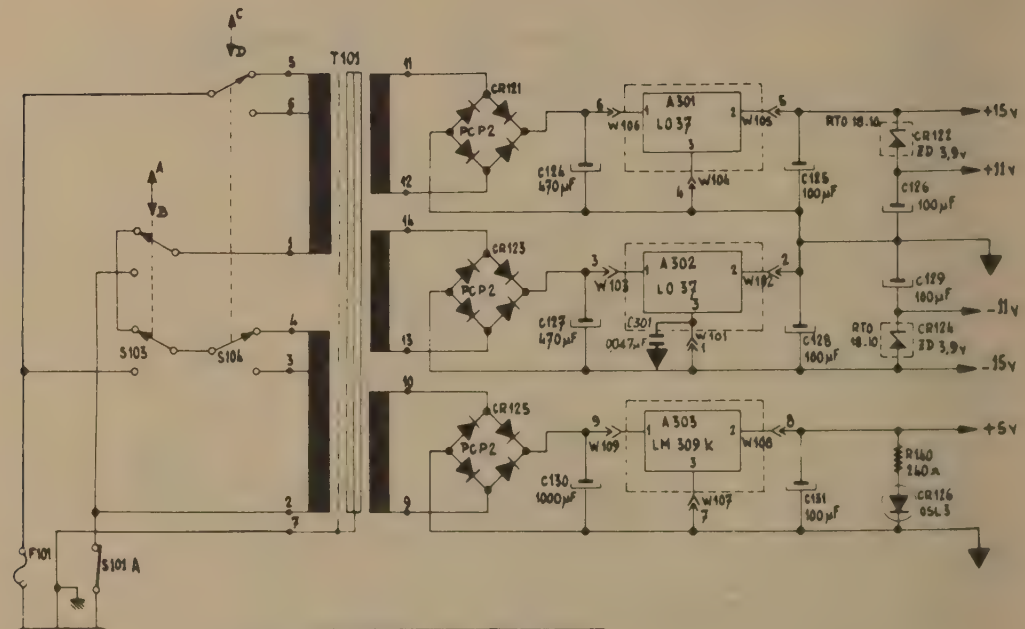
DISASSEMBLY



K 1414 PC Board

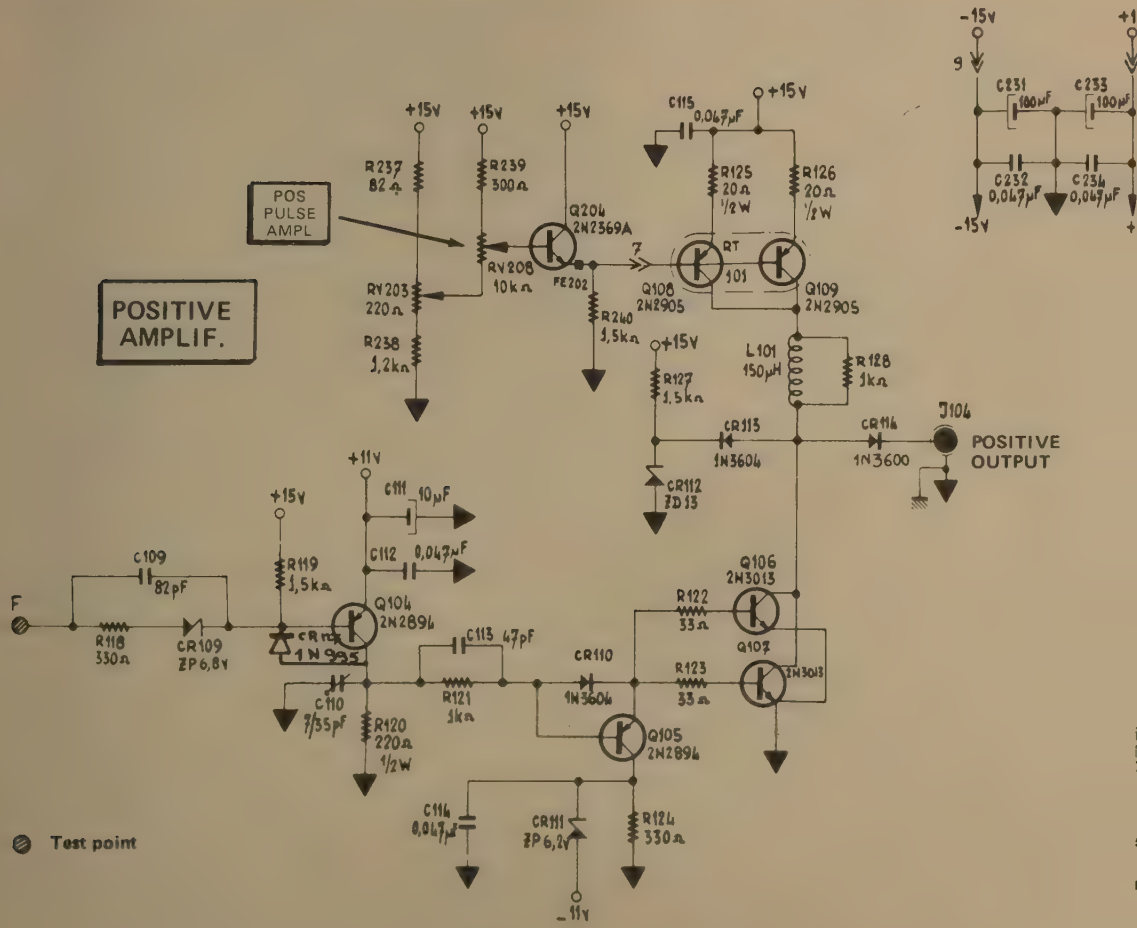


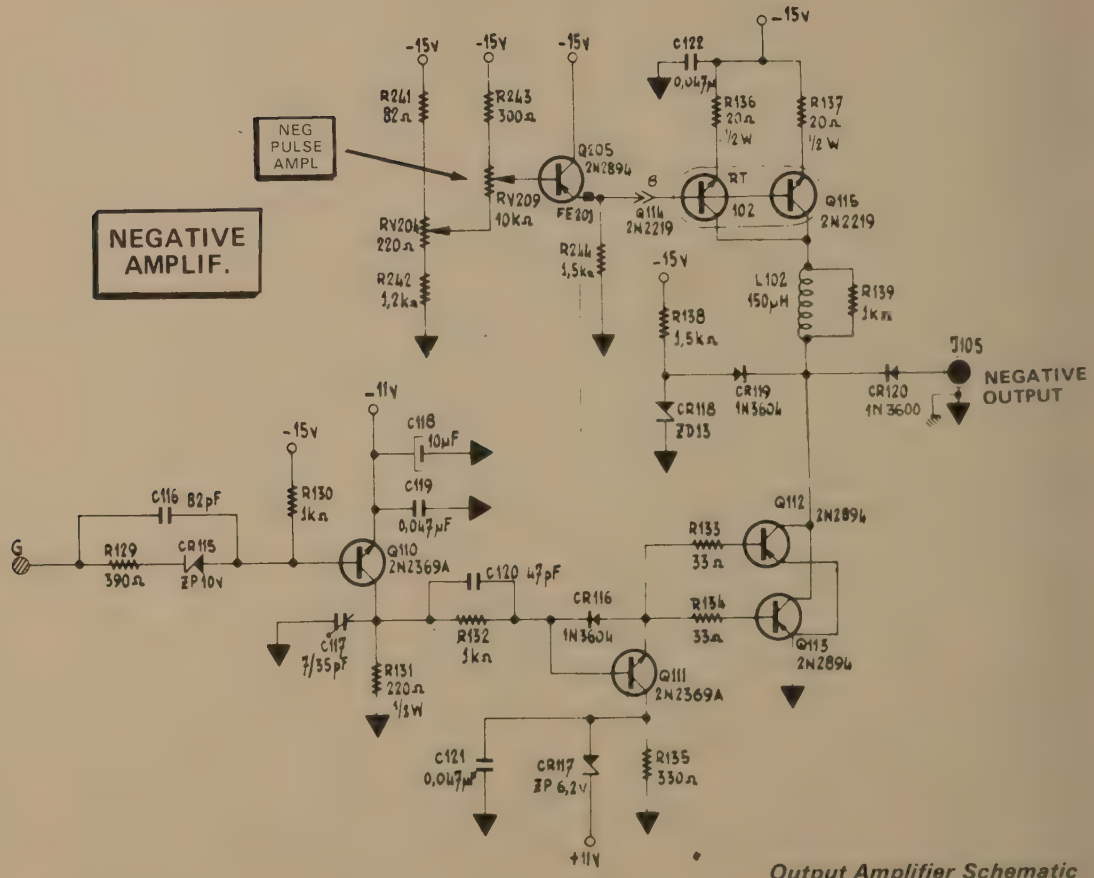
K 1416 PC Board



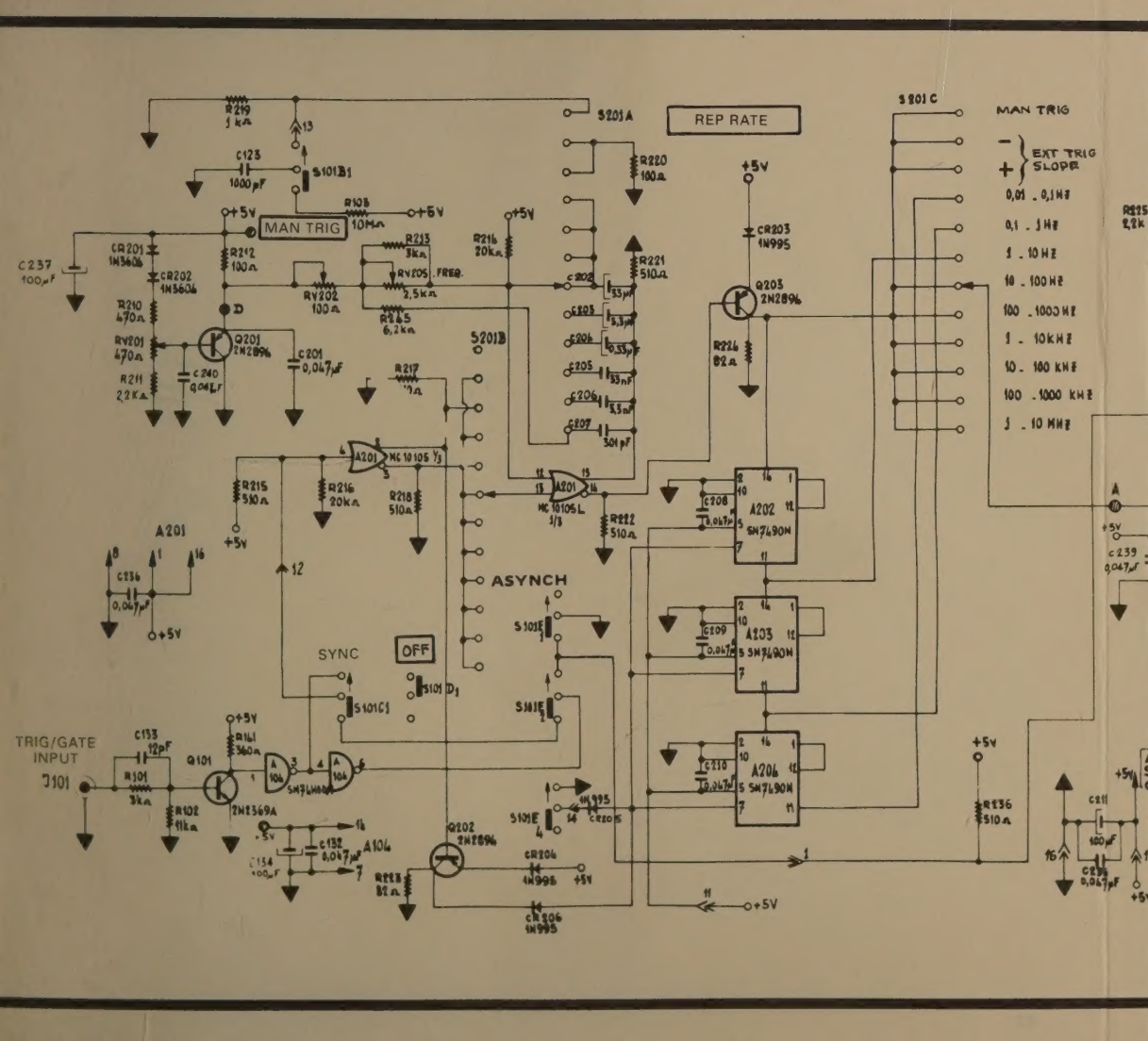
V	C	D	F 101
A	208 – 252 V	180 – 220 V	0,25 A TD
B	104 – 126 V	90 – 110 V	0,5 A TD

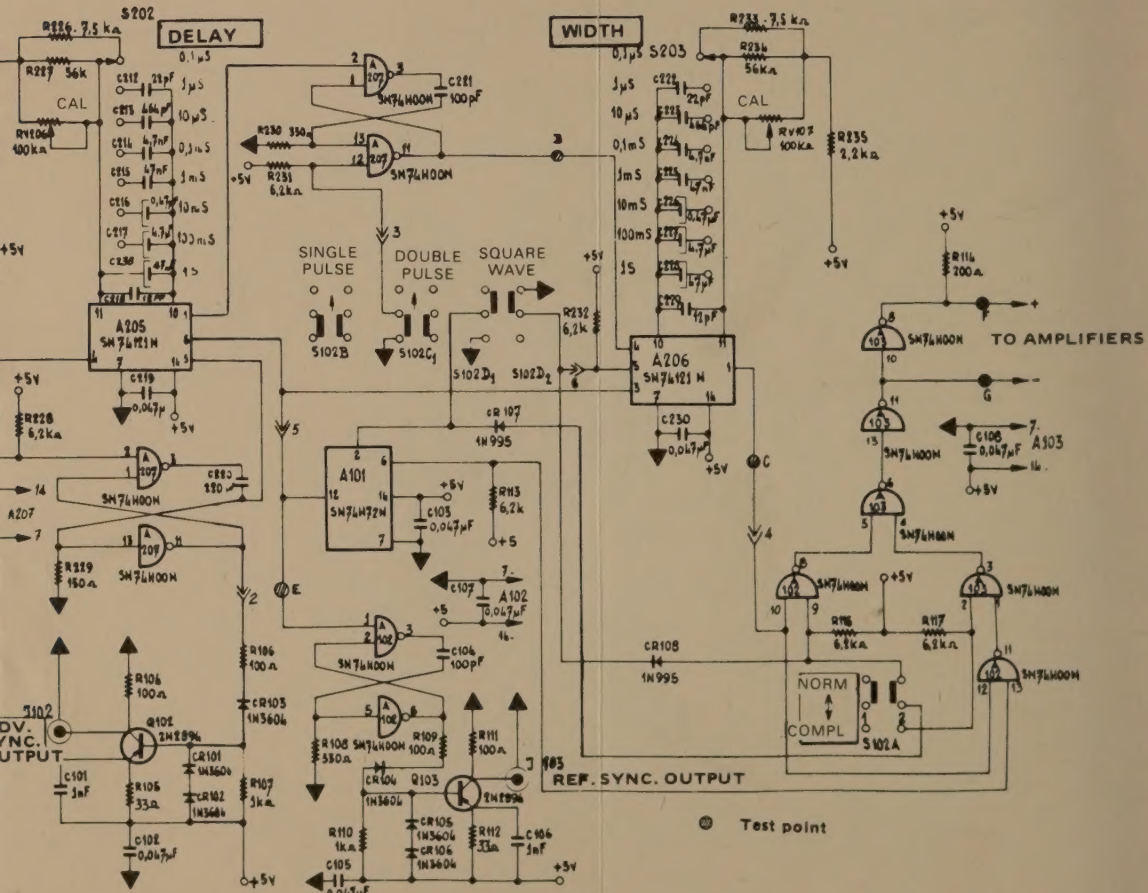
Power Supply Schematic


POS PULSE AMPL
POSITIVE AMPLIF.
+15V
+15V
+15V
+15V
C115 0,047µF
R237 82Ω
R239 300Ω
R125 20Ω 1/2W
R126 20Ω 1/2W
Q204 2N2369A
RV208 10kΩ
FE202
RT 101
Q108 2N2905
Q109 2N2905
RV203 220Ω
R238 1,2kΩ
R240 1,5kΩ
R127 1,5kΩ
L101 150µH
R128 1kΩ
J104
POSITIVE OUTPUT
CR113 1N3604
CR114 1N3600
CR112 ZD13
+11V
C111 10µF
C112 0,047µF
C109 82pF
R119 1,5kΩ
Q104 2N2894
Q106 2N3013
Q107 2N3013
R122 33Ω
R123 33Ω
F
R118 330Ω
CR109 ZP6,8V
CR110 1N914
C113 47pF
CR110 1N3604
C110 7/35pF
R120 220Ω 1/2W
R121 1kΩ
Q105 2N2894
C114 0,047µF
CR111 ZP6,2V
R124 330Ω
-11V
Test point
-15V
C231 100µF
C233 100µF
C232 0,047µF
C234 0,047µF
-15V



Output Amplifier Schematic


REP RATE
S201A
S201B
S201C
MAN TRIG
MAN TRIG
EXT TRIG SLOPE
0,01 . 0,1 HZ
0,1 . 1 HZ
1 . 10 HZ
10 . 100 HZ
100 . 1000 HZ
1 . 10 KHZ
10 . 100 KHZ
100 . 1000 KHZ
1 . 10 MHZ
ASYNCH
SYNC
OFF
TRIG/GATE INPUT
J101
A201
A202
A203
A204
A104
Q101
Q201
Q202
Q203
+5V



Clock Schematic

Subsidiary of A-T-O Inc.

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